Energy efficiency, fuel poverty and rebound: multiple benefits trade-off and asymmetries

EPSRC Grant Ref. EP/M00760X/1

G. Figus* K. Turner* P. McGregor**

*Centre for Energy Policy University of Strathclyde, Glasgow

**Fraser of Allander Institute University of Strathclyde, Glasgow

RSAI BIS, 1st September 2016

UNIVERSITY of STRATHCLYDE
INTERNATIONAL PUBLIC POLICY INSTITUTE
CENTRE FOR ENERGY POLICY

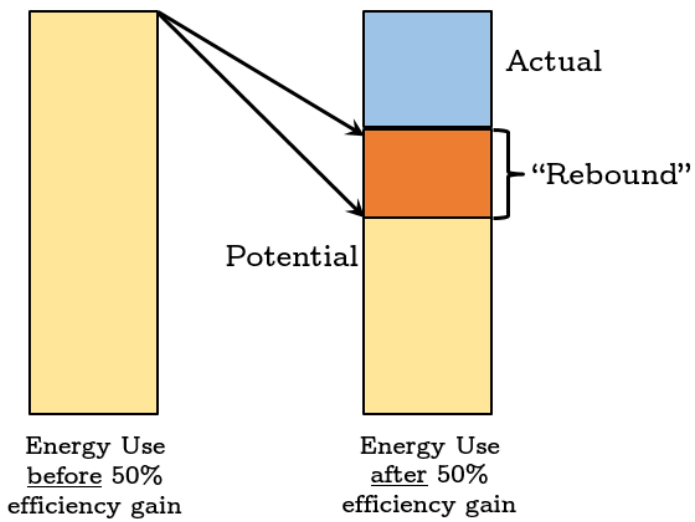
Research Councils UK Energy For a Low Carbon Future

Energy efficiency and household's income groups

- In this study we analyse the 'general equilibrium' effects of improving households energy efficiency across five households income groups using UK (and Scotland) as case study.
- Household energy consumption constitutes around 1/3 of total energy use.
- Energy efficiency improvement can help reducing total energy demand (and GHG emissions).
- Energy efficiency can be associated with a wider range of economic benefits(IAE 2014).
- Rebound effect can help reducing fuel poverty.

Energy efficiency and rebound effect

The introduction of energy efficiency enhancing technological improvements can be useful to reduce final energy consumption. However, potential energy saving from more efficient energy use can eroded by the behavioural response of economic agents. This is the **rebound effect**.



Different region different fuel poverty measure

- *"A household is in* **fuel poverty** *if it would be required to spend more than 10% of its income (including Housing Benefit or Income Support for Mortgage Interest) on all modelled household fuel use"* (The Scottish Government 2012).
- *"Fuel poverty in England is measured using the Low Income High Costs (LIHC) indicator. Under the LIHC indicator, a household is considered to be fuel poor if:*
  1. *they have required fuel costs that are above average (the national median level).*
  2. *were they to spend that amount, they would be left with a residual income below the official poverty line."* (DBEIS 2013).

Household energy efficiency and rebound

General equilibrium Lecca et al. (2014) study the economic impact of a broad-brush 5% improvement in the energy efficiency of UK households. They find that this can stimulate the economy through an increase and change in patterns in domestic aggregate demand.

Only assume one representative household and consider energy efficiency improvements in total household energy use. Only considers a costless energy efficiency improvement.

Partial equilibrium studies have focused on estimating the direct and indirect rebound effect across different household income groups (e.g. Chitnis et al. 2014 for UK, Murray 2013 for Australia, Thomas and Azevedo 2013 for U.S.). Their common finding is that low income households are typically associated with a higher rebound effect.

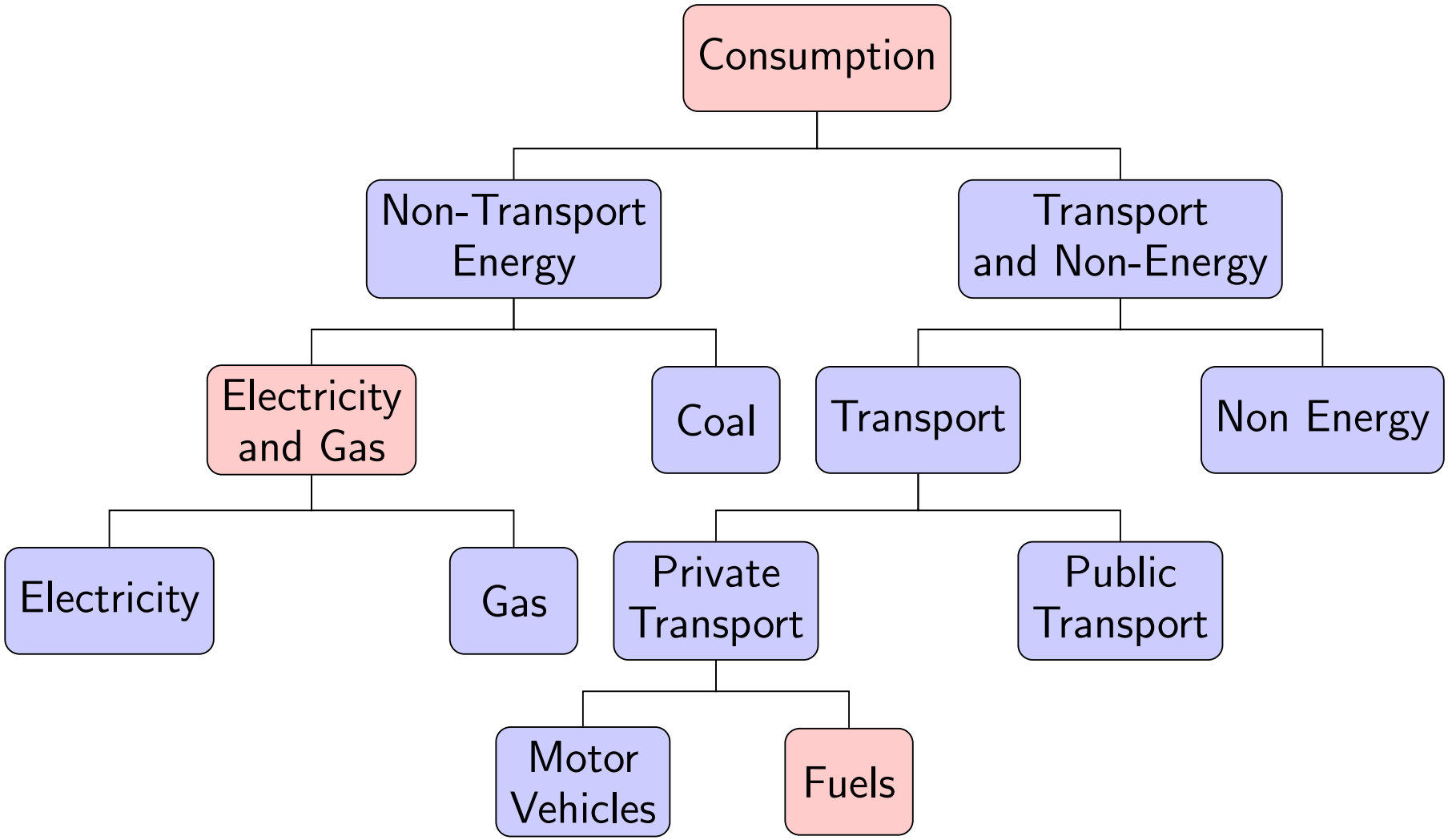
Do not capture the full economy-wide rebound effect because they do not consider the effect of market price and nominal income variations.

Objectives

- Analyse the impact of improving total household's energy efficiency distinguishing between different income groups, and accounting for rebound in different groups.
- Consider energy efficiency improvements in different household's energy uses.
- Consider the case where the Government pays for improving energy efficiency, with a permanent or temporary change in spending/tax and what are the implications for the economy.

- We use a dynamic CGE model for UK specifically designed to examine impacts of to disturbances in energy supply and demand.
- The model account for transactions between 30 industries.
- The household sector is disaggregated in 5 income quintiles.
- We assume that each representative household allocates consumption at each period following a myopic behaviour.
- Investment decision are made by a forward-looking profit maximiser representative agent.

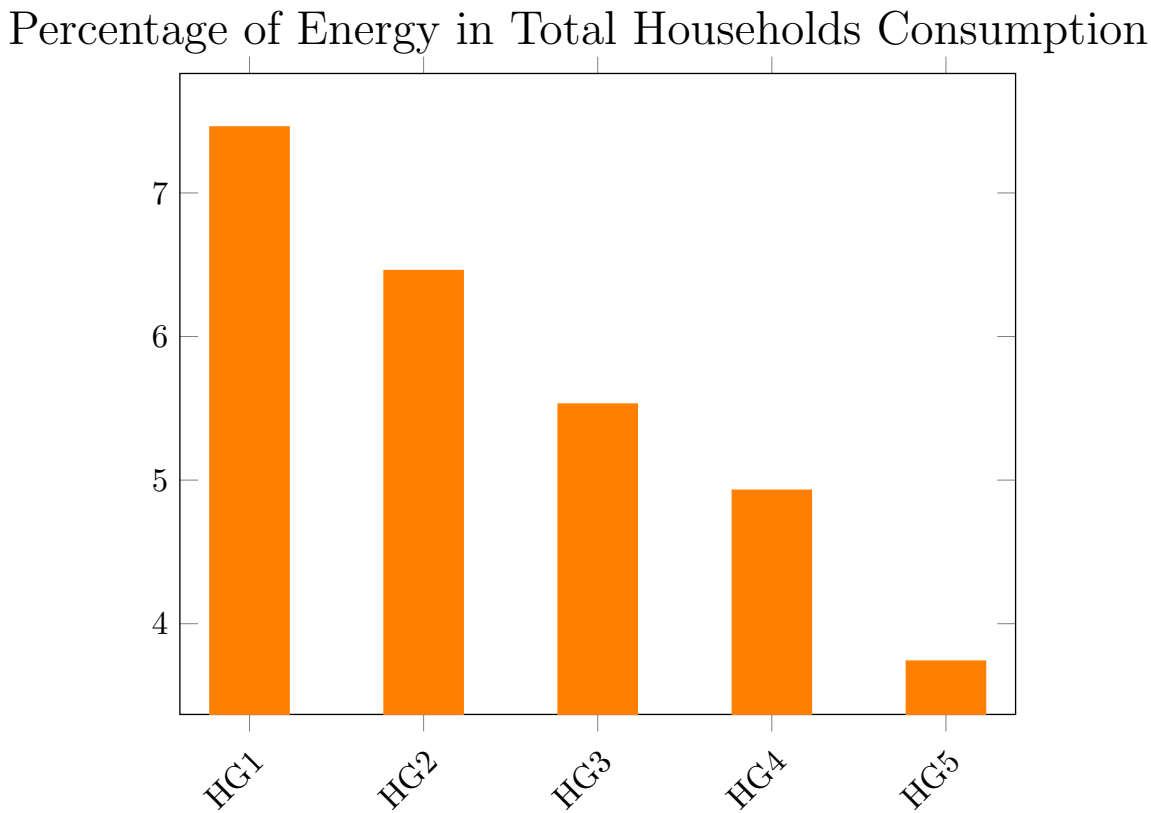
The Structure of Consumption



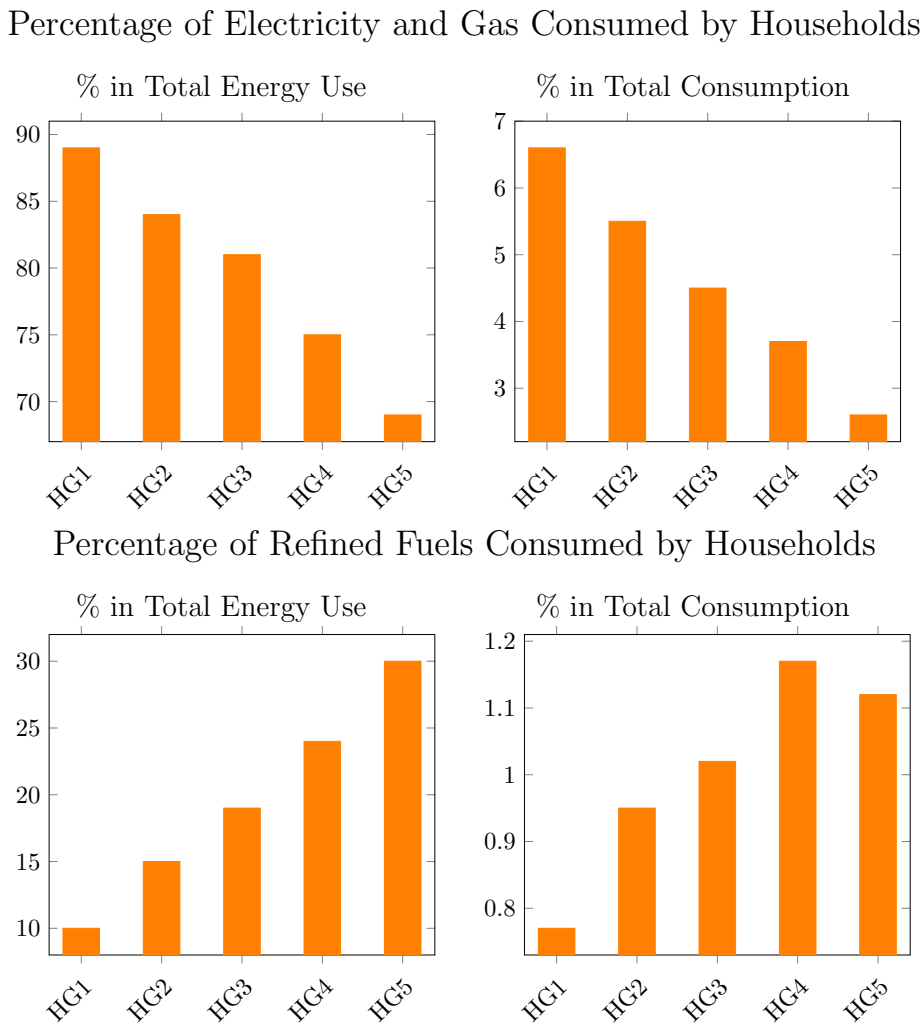
Disaggregating the household sector in the UK 2010 SAM

Table 1: Income quintiles disaggregation per week

HG1	HG2	HG3	HG4	HG5
up to £237	£238 - £412	£413 - £650	£651 - £1,014	£1,015 and over



Patterns in energy consumption



Macroeconomic impacts

Table 2: 10 % increase in total household energy efficiency

	SR	LR
GDP	0.04	0.21
CPI	0.45	0.29
Unemployment	-1.16	-2.84
Total Employment	0.07	0.18
Nominal wage	0.58	0.62
Real wage	0.13	0.33
Investment	1.55	1.06
Exports	-0.66	-0.51
Energy output	-0.84	-1.44
Non energy output	0.15	0.32
Industry energy use	-0.52	-0.86
Household consumption		
Total consumption	1.09	1.18
Non energy consumption	1.32	1.43
Energy consumption	-3.15	-3.40
Household rebound	68.47	66.02
Economy wide rebound	57.02	45.84

Disaggregating household consumption

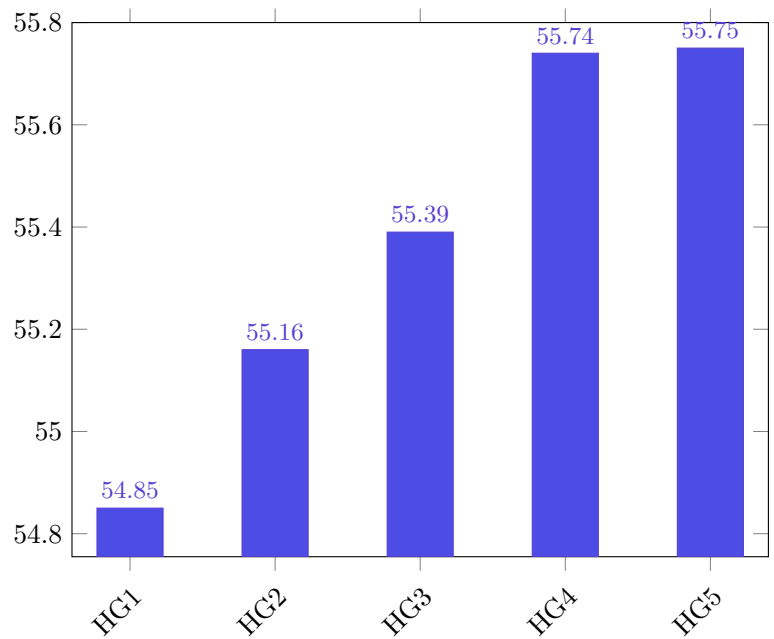
Table 3: Impacts on consumption across household income groups of a 10 % increase in total household energy efficiency

	HG1		HG2		HG3		HG4		HG5	
%change	SR	LR	SR	LR	SR	LR	SR	LR	SR	LR
Total energy	-2.88	-3.23	-3.07	-3.37	-3.20	-3.46	-3.28	-3.48	-3.45	-3.65
Non energy	1.82	1.85	1.59	1.65	1.41	1.50	1.31	1.45	1.07	1.20
Energy/income	-2.94	-3.30	-3.13	-3.49	-3.28	-3.65	-3.35	-3.73	-3.54	-3.89
Household rebound	71.19	67.70	69.30	66.27	67.98	65.38	67.21	65.19	65.50	63.47

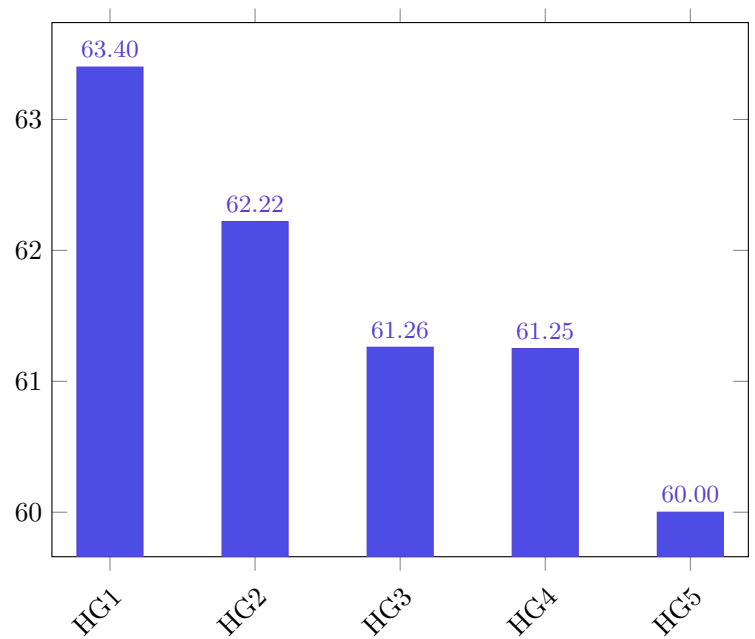
Results confirm findings in previous partial equilibrium studies of low income households being associated with bigger rebound effects.

Asymmetric rebound effect between different household energy uses

Household Rebound Effect in Refined Oil Use from a 10% Increase in Refined Oil Efficiency



Household Rebound Effect in Electricity and Gas Use from a 10% Increase in Electricity Efficiency



How can the Government pay for efficiency improvement

The household energy efficiency improvement can be funded by either an increase in Government income (GY) or a reallocation of Government spending (GEXP)

$$GOVBAL_t = GY_t - GEXP_t + \Delta CE\gamma_t \quad (1)$$

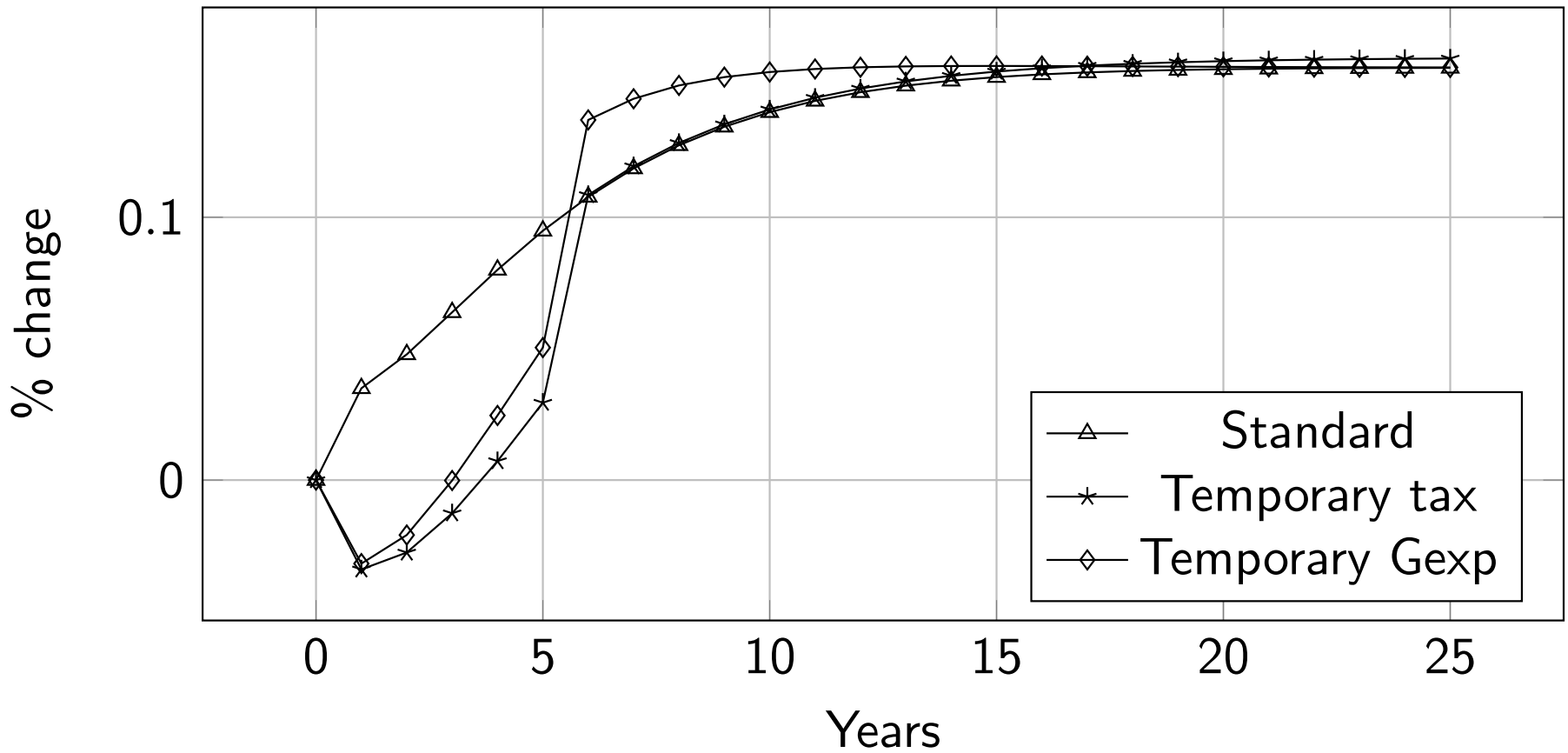
We can imagine that this has to be paid permanently or temporarily. Here we explore both cases.

Table 4: Impact on energy consumption of improving electricity and gas efficiency in all households and in only household group 1 under different scenarios

	Standard		**Temp Tax**		**Temp Gov**	
	SR	**LR**	**SR**	**LR**	**SR**	**LR**
% change in E/Y	-2.83	-3.18	-2.95	-3.17	-2.89	-3.18
Level change E/Y	-67.03	-72.26	-65.42	-72.22	-64.31	-72.26
% change HG1 Y	0.09	0.09	0.04	0.09	0.03	0.09
Level change HG1 Y	23.13	24.02	11.72	24.28	6.88	24.02
% change E and G	-3.29	-3.66	-3.44	-3.66	-3.40	-3.66
Level change E and G	-163.42	-181.81	-170.96	-181.72	-168.96	-181.81
% change GDP	0.03	0.16	-0.03	0.16	-0.03	0.16
% change real wage	0.10	0.24	0.21	0.24	-0.09	0.24

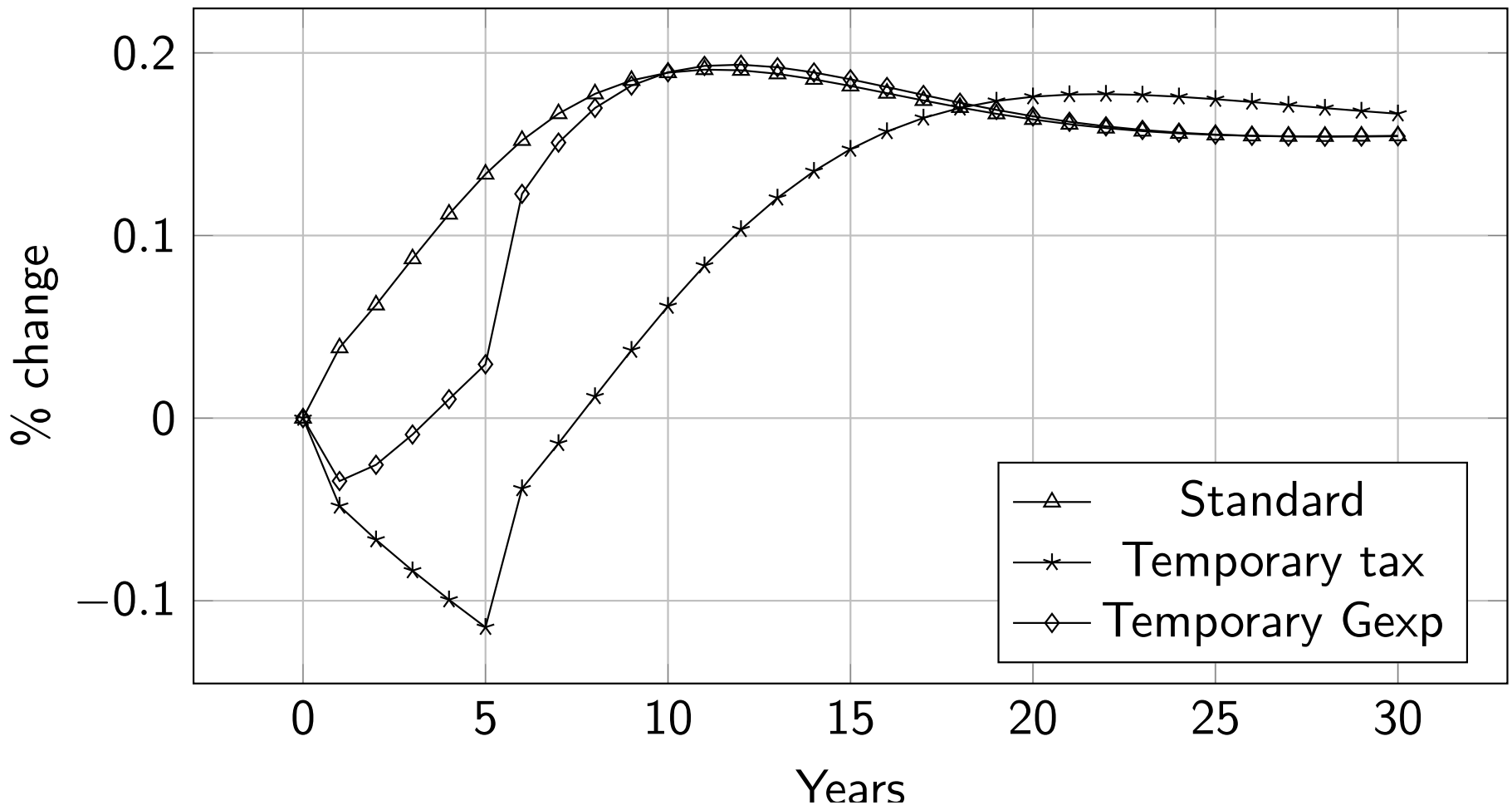
Impact on GDP with forward looking investment

Figure 1: Period by period % change in GDP



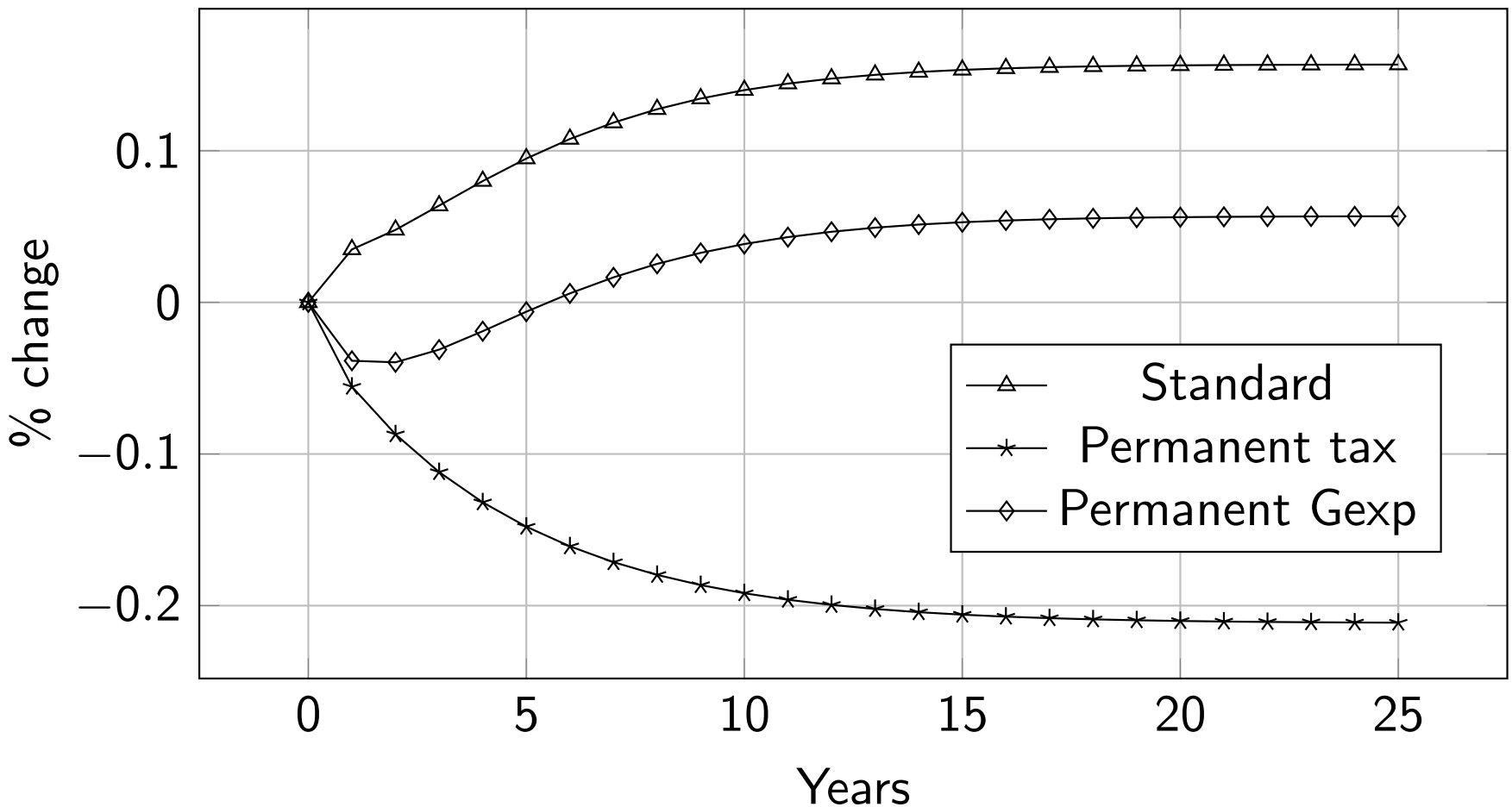
Impact on GDP with myopic investment

Figure 2: Period by period % change in GDP



Impact on GDP of a permanent budget change

Figure 3: Period by period % change in GDP



Conclusion

- Income groups consuming a certain energy good more intensively tend to rebound more in the use of the same good.
- Energy efficiency can be effective to reduce fuel poverty (because of the rebound effect!).
- When government is paying for efficiency by temporarily changing its balance, the tax is more effective in terms of fuel poverty reduction but worst for the whole economy.

Conclusions

- When investment are myopic short run GDP decreases by more, because of absence of expectation.
- However, long-run results are the same.
- When the change in the Government's budget is permanent, funding the efficiency improvement through a change in Government spending delivers the best medium to long-term outcome in terms of economic benefits.

Thank You for Your Attention
Gratzias meda po s'atenzioni